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## TECHNICAL REPORT

### SUBJECT: LIFEBOOYS TYPE ALTURA

#### 1. Non-conformity analysis

Having received communication from the Swedish Transport Agency, about the occurrence of a fault on some of our Lifebuoys Altura model sold in Sweden, we have requested the withdrawal and the shipment to our laboratory of all the devices that seemed defective.

In the same time, we have delivered new equipment to replace the ones mentioned above in order to guarantee the compliance of the relevant ships with the required safety standards.

The anomaly is reported to be: "lack of buoyancy material into the shell".

Upon receipt of the equipment, we carried out a preliminary visual inspection whose results are listed below:

- Six Lifebuoys Altura model received presumably installed on two different ships.
- Three of them belong to 01/2004 production lot, the other three to 03/2005 production lot.
- All devices have been sectioned to inspect the buoyancy material.
- In two of the three devices belonging to the production lot 01/2004, the buoyancy material shrank allowing water to penetrate the shell impairing the buoyancy capacity of the equipment to a level not compliant with the applicable requirements.
- Marks caused by indentations of the shell internal surface have been detected all around the buoyancy material surface. Such marks show that the buoyancy material has filled the shell during production and has solidified in contact with shell surface. This means that the lifebuoys were completely filled during production.
- No findings have been detected in the third lifebuoy from 01/2004 lot and in all items from 03/2005 lot.



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A buoyancy material sample taken from the two defective items has been sent to an external laboratory for chemical analysis of the components of the material.

At the same time, items of the same lifebuoy model from 2003 to 2005 (included) production lots have been investigated in order to seek other findings, not necessarily similar to the one described above.

The outcome of this check showed that only 01/2004 lot contained defective items.

The actions taken by the company to analyze and solve the non-conformity are described in the following paragraphs.

### 1. Actions taken

- a. Tracing of all Altura lifebuoys belonging to the 01/2004 production lot; consequent demand to customers to make an initial visual inspection on items to detect any anomalies and subsequent request to send at makers premises all devices suspected to have deficiencies, insuring the replacement of the same item (Annex 1)
- b. Analysis of production control reports relevant to Altura 01/2004 lot.
- c. Analysis of reports of laboratory tests performed on the foam of the two defective devices.
- d. Performance of tests on Altura lifebuoys currently under production.

### 2. Analysis of the results

- a. Tracing of the production lot:  
All relevant clients have been traced. The company is going to contact them asking the withdrawal of the items suspected to be defective and the submission of any relevant claim report received from final users. See Annex 1.
- b. Production control report analysis  
No findings or anomalies have been found in the production control report relevant to 01/2004 lot. See Annex 2 "Value Test No.68" of 06/02/2004.
- c. Analysis of laboratory reports on the components of the foam.  
The two basic components (Isocyanate and Polyol) have been identified and found within the standard ratio for such a material (rigid polyurethane foam). The density of the foam has been found above the standard value. See Annex 3.



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#### d. Analysis of laboratory reports on Altura lifebuoy samples

Some tests have been performed at RINA laboratory on two lifebuoys sampled from 10/2009 production lot.

The first sample has been subjected to the temperature cycling test prescribed by Res. MSC.81(70) par. 1.2: at the end of the test, the specimen has been visually examined and no damage on the shell nor shrinkage of the filling foam have been detected. See Annex 4.

The second sample has been exposed to -30°C for a period of 120 hours. This test is not required by Res. MSC.81(70) and has been performed in order to evaluate the lifebuoys behaviour at extended exposure at low temperature, aiming at reproducing the climatic conditions which may occur in the Northern Europe, since defective items have been found in that geographical area. No damage on the shell nor shrinkage of the filling foam have been detected after the test. See Annex 5.

### 3. Conclusions

Upon examination of the analysis results, the failure origin is identified in the production process.

Having reviewed the production phases (see Annexes 6a and 6b), it is deemed that the homogeneous shrinkage of the buoyancy material inside the shell was due to an event external to the buoyancy material injection process.

Such process is managed by a specific machine that draws the two basic components (isocyanate and polyol) from relevant tanks, mixes and injects them through a hole on the top of the lifebuoy shell that is placed in a vertical position.

The basic component percentage, the quantity of mixed material to be injected, the mixing and injection time are set on the machine and controlled during production. The machine has been always kept in duly state of maintenance and calibration, according to the relevant company instructions, and no mistakes in the machine settings have ever been detected. See Annexes 6a, 6b and 7.

The shell proper filling is checked by operator through visual inspection: the foam fills the shell until it gets out from the injection hole.

The cause of the defect is deemed to be an external agent that could have prevented the proper chemical reaction of the two components once the mixture has been injected into the shell.

For this purpose, it is to be considered that from December 2003 till February 2004, due to maintenance works in the warehouse where the production process takes place, empty shells of Altura lifebuoy model were stored under a shelter outside the warehouse. Even if the shells were not exposed to direct action of



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atmospheric agents, e.g. rain or snow, they could have been affected by the high humidity present in the surrounding environment. It is deemed that humidity entered the lifebuoys shells through the hole used for the foam injection and water condensed on internal surface to a level unsuitable for the proper completion of the subsequent filling process.

It is known the water may alter the chemical reaction between the two components, since both isocyanate and polyol become instable when in contact with water before the chemical reaction is completed.

As confirmed by two independent producers of polyurethane foam (see Annexes 8a and 8b), if water comes in contact with the foam during injection, it reacts with part of the isocyanate present in the mixture altering the stoichiometric ratio of the remaining part of the mixture itself. This leads to instability of the foam and consequent foam shrinkage after a period of few months, depending on the climatic conditions which the item is exposed to.

It would have therefore been impossible for the operator to detect the defect after the injection was completed and during lifebuoys final checks, since the foam did not show any visible alteration before lifebuoys shipment to clients.

In order to improve production quality during wintertime, between April and May 2004, the company modified the production process by adding a pre-heating equipment for lifebuoy shells before the injection station. In fact, if the injection is performed at wintertime ambient temperature, the foam flows into the shell hardly and does not pour out from the injection hole. The operator can easily detect this during visual inspection. As a consequence of the shell pre-heating setting at 60°C for 120 seconds, the occurrence of incomplete filling and consequent reject of lifebuoys has been reduced.

It is believed that such modification, aimed to reduce production reject at low ambient temperature, may have had beneficial effects on the removal of humidity from shells.

## 4. Corrective/preventive actions planned

It has been decided to increase the shell pre-heating time from 120 to 210 seconds.

At the same time, specific instruction will be provided to all production staff in order to focus their attention on the maintenance of environmental conditions during shell storing.

Furthermore, it has been decided to introduce, as an additional safety measure, a new closing device on the injection hole: in addition to the rigid buoyancy material and to the refractive tape, placed on the hole, that have been used since now, a new polyethylene plug will be forced onto the hole so that it



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cannot be removed unless the shell itself is damaged. The refractive tape will be placed on the plug as a further means of seal. This new arrangement will be tested during the prototype tests that will be carried out in compliance with the latest amendments to the mandatory reference standard Res. MSC.81(70).

*Cristian Cella*  
R&D Manager and Quality Assurance

November, 27th 2009  
Casarza Ligure (Genova)



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